Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/169
UNITED KINGDOM
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

CALCULATION OF REACTOR POWER AND TEMPERATURE DISTRIBUTION IN THREE SPATIAL DIMENSIONS

by

*A. B. Whiteley

*R. Prescott
+J. J. Syrett
xDr. J. Walsh
oA. N. Buckler
oJ. G. Tyror
=Dr. H. E. Wrigley

The paper describes the development of a large computer program written for the IBM 7090 computer to calculate steady state reactor power and temperature distributions in three spatial dimensions.

The major part of the calculation is the solution of the group diffusion equations for up to five energy groups in a non-linear form, i.e. with explicit reactivity feed-back effects due to material temperatures and to xenon-135 concentration. The diffusion equations are solved by finite-difference methods using a point successive over-relaxation iterative scheme with Chebyshev extrapolation of the sources. The ancillary equations defining temperatures and xenon-135 concentration are solved periodically; the coefficients of the diffusion equations are then re-evaluated and the finite-difference matrices modified accordingly before proceeding with further flux iterations. The reasons for the choice of numerical techniques employed are discussed and programming methods and problems are noted.

*Computing Branch, Research and Development Department, C.E.G.B., London
+Reactor Physics Section, Research and Development Department, C.E.G.B., London
xDepartment of Mathematics, Manchester University
oReactor Development Laboratory, U.K.A.E.A., Windscale
=Atomic Energy Establishment, U.K.A.E.A., Winfrith

Two new techniques have been developed to increase the scope of the diffusion calculation. These are firstly, a method of representing discrete absorbers (control rods) at any point within a finite difference mesh and secondly, a method of super-imposing a fine structure calculation of the source-sink type on the macroscopic flux distribution obtained from the diffusion theory calculation. These techniques (which are described in some detail) have been developed in order that detailed studies of complete power reactors can be made without the use of an excessive number of finite difference mesh points when solving the diffusion equation.

At the time of writing (December 1963), the main diffusion program together with subsidiary programs to calculate flux fine structure and absorber data have all been written and tested. The diffusion program has shown satisfactory rates of convergence in both two group and five group cases and the computation time is considered to be reasonable.

Intended future use of the program by both the C.E.G.B. and the U.K.A.E.A. is discussed and the extension of the basic steady state diffusion program to a time-dependent model for the study of reactor transients is also noted.